BIOMEDICAL ENGINEERING, PH.D.

The biomedical engineering Ph.D. program at Saint Louis Engineering will strongly focus on independent research and innovation, pursuit of academic excellence, strong industry partnerships, innovative teaching methodologies, and diversity and inclusion. These elements will collectively prepare students for successful careers and address the evolving needs of the region, nation, and world.

As part of their degrees, the students will take graduate-level courses at SLU to deepen their knowledge, understanding and skills in the discipline as well as perform independent discovery or design-focused original research under the guidance of a graduate faculty member. The degree will culminate in the defense of a dissertation as well as original research publications in peer-reviewed journals and research presentations at local and national scientific conferences. This high level of scholarship will increase the department’s visibility and reputation among peer institutions and will position our graduates to become leaders in their chosen fields.

Curriculum Overview

This is a 42-credit-hour program, with 30 hours of coursework and 12 hours of Dissertation Research. Full-time students typically would complete their coursework in two and a half years. Students will have a choice between a written or an oral qualifying exam, which they will take by the end of their second year in the program. They will have an oral defense of their dissertation proposal at the end of their coursework.

Fieldwork and Research Opportunities

School of Science and Engineering graduate students gain valuable experience working with both faculty and peers. Additional opportunities to publish in scientific journals and attend professional conferences prepare our graduates for careers in industry or academia.

Saint Louis University's location in a vibrant and industry-rich city means that faculty members have access to and relationships with industry professionals. The School of Science and Engineering provides many opportunities for these professionals to interact with students, share their real-world experiences, network and even collaborate on research projects. Therefore, students have access not only to top-notch faculty but to the most recent developments in industry.

The expert faculty of the School of Science and Engineering collaborate with graduate students in groundbreaking research in the following areas:

- Biomaterials
- Human movement
- Drug delivery
- Engineering education
- Haptic and human-machine interfaces
- Innovation and entrepreneurship
- Biomechanics
- Mechanotransduction
- Neuroengineering
- Tissue engineering and regenerative medicine

Careers

Graduates of the doctoral program seek employment in the industry, government or in an academic setting.

Admission Requirements

Apply Here (https://www.slu.edu/apply.php)

Most admitted students meet the following criteria:

- Undergraduate cumulative GPA of at least 3.00
- A four-year undergraduate degree in Biomedical Engineering, Bioengineering, Biochemical/Biomolecular/Bioelectrical Engineering or closely related engineering and science discipline
- Additional consideration will be prior research experience demonstrated by the applicant, which could be in the form of an earned thesis MS degree from a previous institution or an undergraduate research experience with a demonstrated research output (e.g., conference presentations, publications, etc.). Such students will be given higher consideration for acceptance into the program even though students coming directly from a BS degree with no prior research experience will also be considered if they clearly demonstrate an ability and motivation to conduct independent scientific research.
- Acceptance decisions will be based on BME faculty expertise and lab openings such that incoming students can be successfully matched with a faculty member to conduct a research project that is in alignment with the student's preparation, interest, and career goals.

Application Requirements

- Application form
- Transcript(s) from all colleges and universities attended
- Three letters of recommendation (preferably from recent instructors or research advisors)
- Résumé or curriculum vitae
- Professional goal statement

Requirements for International Students

Along with the general admission requirements above, the following must be provided by prospective international students:

- Demonstration of English Language Proficiency (https://catalog.slu.edu/academic-policies/office-admission/graduate/english-language-proficiency/).
- Proof of financial support that must include:
  - A letter of financial support from the person(s) or sponsoring agency funding the time at Saint Louis University.
  - A letter from the sponsor's bank verifying that the funds are available and will be so for the duration of study at the University.
- Academic records, in English translation, for postsecondary studies outside the United States. These must include the courses taken and/or lectures attended, practical laboratory work, the maximum and minimum grades attainable, the grades earned or the results of all end-of-term examinations, and any honors or degrees received. WES and ECE transcripts are accepted.

Review Process

Applications for the Ph.D. program will be sent to the BME Department for evaluation and an admission decision will be based on BME faculty expertise and lab openings. The goal is to ensure a successful match
with a faculty member to conduct a research project that is in alignment with the student’s preparation, interest, and career goals.

In cases where students come from a non-biomedical engineering background, the applications will be sent to the BME program to review and determine if and/or pre-requisite/concurrent classes that the applicant would need to take to qualify for doctoral studies in BME. The students will receive conditional acceptance and the classes they need to take will be specified in SLATE and in the offer letter.

### Tuition

<table>
<thead>
<tr>
<th>Tuition</th>
<th>Cost Per Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate Tuition</td>
<td>$1,370</td>
</tr>
</tbody>
</table>

Additional charges may apply. Other resources are listed below:

- Information on Tuition and Fees (https://catalog.slu.edu/academic-policies/student-financial-services/tuition/)
- Miscellaneous Fees (https://catalog.slu.edu/academic-policies/student-financial-services/fees/)
- Information on Summer Tuition (https://catalog.slu.edu/academic-policies/student-financial-services/summer-tuition/)

### Financial Support

The School of Science and Engineering offers graduate fellowship awards and assistantships each year. Assistantships provide tuition, stipend and health insurance. There are also many opportunities for students to receive funding through external research grants that are managed by individual faculty.

For more information, visit the student financial services office online at www.slu.edu/financial-aid (https://slu.edu/financial-aid/).

### Learning Outcomes

1. Graduates will demonstrate in-depth knowledge of theories and methodologies, to address fundamental questions in their primary field of study.
2. Graduates will engage in meaningful research within the field or explore interdisciplinary or innovative projects. Under the mentorship of an advisor, students will both design and execute research projects while developing intellectual independence; creatively synthesize broad areas of theory and scholarship to generate novel concepts and insights; demonstrate the capability to critically assess scholarly works within the discipline.
3. Follow the principles of ethics in their field and academia. Demonstrate, through independent research and service, the value of their discipline to the academy and community at large. Interact productively with people from diverse backgrounds as both leaders/mentors and team members with integrity and professionalism.
4. Students will demonstrate skills in oral and written communication, enabling them to disseminate their work effectively in their field. Students will produce original scholarly contributions in their field.
5. Students will attend and/or present their independent research to local, regional, national, or international audiences through presentations given in a range of venues, from graduate seminars to professional meetings and/or conferences/symposia/workshops; participate in professional organizations; engage in professional activities such as teaching, internships, fellowships, grant applications.

### Requirements

#### Required Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME 5010</td>
<td>Research Analysis</td>
<td>3</td>
</tr>
<tr>
<td>BME 5040</td>
<td>Technical Communication in the Discipline</td>
<td></td>
</tr>
</tbody>
</table>

#### Foundational Courses

- Students select 6 credits from the following:
  - BME 5130 Medical Imaging
  - BME 5410 Tissue Engineering
  - BME 5600 Quantitative Physiology I
  - BME 5650 Quantitative Physiology II
  - BME 5400 Tissue-Material Interfaces
  - BME 5210 Human Movement Biomechanics

#### Electives

Select 21 credits from the following:

- AENG 5230 Introduction to Computational Fluid Dynamics
- BIOL 5080 Advanced Cell Biology
- BIOL 5430 Advanced Principles of Virology
- BIOL 5630 Concepts of Immunobiology
- BIOL 5640 Advanced Microbiology
- BIOL 5700 Advanced Molecular Biology
- BIOL 5720 Advanced Cancer Biology
- BME 4200 Biomechanics
- BME 4400 Biomaterials
- BME 5100 BioData Processing and Machine Learning
- BME 5150 Brain Computer Interface
- BME 5300 Biotransport
- BME 5320 Drug Delivery
- BME 5340 Biofluids
- BME 5420 Tissue Engineering Scaffold Fabrication Techniques
- BME 5430 Regenerative Engineering
- BME 5455 Biomaterials Characterization and Instrumentation
- BME 5850 Design of Biomedical Engineering Lab Experiments
- BME 5910 Co-op with Industry (maximum of 3 credits)
  or BME 5915 Internship with Industry
- BME 5930 Special Topics
- BME 5970 Research Topics
- BME 5980 Graduate Reading Course
- BME 6000 Preparing Future Faculty
- BME 6930 Special Topics
- BME 6970 Research Topics
- BME 6980 Graduate Reading Course
- BST 5100 Introduction to General Linear Modeling
- CHEM 5610 Biochemistry 1
- CHEM 5630 Introduction to Chemical Biology and Biotechnology
- ECE 5153 Image Processing
- HDS 5210 Programming for Health Data Scientists
The qualifying examination is intended to test the student’s fundamental knowledge in biomedical engineering and may be taken no more than twice. If a student is not able to pass this examination after exhausting all of the allowed chances, they could be transferred to the MS degree program or choose to leave the graduate program.

Students who pass the qualifying and dissertation proposal examinations become Ph.D. candidates. A student must be admitted to candidacy at least two full sequential semesters before the date on which the doctorate degree will be conferred.

**Final Defense of the Ph.D. Dissertation**

The dissertation defense is conducted by the student’s Guidance Committee. In the event that not all of the members who served on the proposal examination are available to serve on the dissertation defense committee, substitutions may be made. However, the final makeup of the dissertation defense committee must in all cases consist of at least 3 faculty members from the BME program and at least 1 person from outside the program. The minimum members required is 5.

As part of the dissertation defense, students are required to submit a written dissertation that describes the results from the research.
The student should consult the Formatting Guide for Saint Louis University Graduate Education for details concerning the preparation and format of the Dissertation. The traditional dissertation format typically includes an introduction, a review of the literature, methodology, results, and discussion. In addition, the Department of Biomedical Engineering offers a “manuscript-style” format. This is similar to the non-traditional format described in the Office of Graduate Education’s dissertation formatting guide. If this option is used, the student will normally use the following format: Chapter 1 - Introduction; Chapter 2 - Manuscript #1; Chapter 3 - Manuscript #2; Chapter 4 - Manuscript #3; Chapter 5 - Conclusions and Future Work. With either format, the dissertation must be formatted in accordance with the regulations of Graduate Education. Once completed, the dissertation will be approved by the research mentor and a copy given to each member of the student's Guidance Committee; the dissertation should be distributed two weeks before the public presentation (see below). The committee will evaluate the dissertation, make comments and suggest any necessary corrections or changes.

The dissertation defense will be presented orally in a public seminar lasting 30 to 45 minutes. The open forum is followed by a closed-door session, where the Guidance Committee conducts an oral examination of the student within the area of the conducted research. A 2-hour block should be reserved for the defense. The time and location of defense must be publicized two weeks in advance so that the defense can be attended by all interested persons.

The candidate may only take the final oral defense twice, and students who are not able to pass the defense in two attempts will not be awarded a doctoral degree.

Roadmap

Roadmaps are recommended semester-by-semester plans of study for programs and assume full-time enrollment unless otherwise noted.

Courses and milestones designated as critical (marked with !) must be completed in the semester listed to ensure a timely graduation. Transfer credit may change the roadmap.

This roadmap should not be used in the place of regular academic advising appointments. All students are encouraged to meet with their advisor/mentor each semester. Requirements, course availability and sequencing are subject to change.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year One</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td>BME Foundational class</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>BME Foundational or Elective class</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>BME Seminar</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Credits</td>
<td>6</td>
</tr>
<tr>
<td>Spring</td>
<td>BME Foundational or Elective class</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>BME Elective class</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>BME Seminar</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Credits</td>
<td>6</td>
</tr>
<tr>
<td>Year Two</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td>BME Electives</td>
<td>6</td>
</tr>
</tbody>
</table>

Program Notes

Students should finish their BME foundational coursework (six credits) by the end of year one. BME Seminar (four semesters) should be finished by the end of year two. Students should expect to take their Ph.D. qualifying examination at the end of year two, after four semesters in the program.

The doctoral oral examination (dissertation proposal) should be taken at the end of year three; upon passing the doctoral oral exam, students will become Ph.D. candidates.

Contact Us

For more information about any School of Science and Engineering graduate program, email ssegrad-admissions@slu.edu.